

**Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019**  
**Information Theory and Coding**

Time: 3 hrs.

Max. Marks:100

**Note: Answer any FIVE full questions, selecting  
atleast TWO questions from each part.**

**PART – A**

- Discuss the reasons for using logarithmic measure for measuring information. (03 Marks)
  - Derive an expression for the entropy of symbols in long independent sequence. find the entropy of a source in Nats/symbol of a source that emits one out of four symbols A, B, C and D in a statically independent sequence with probabilities  $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{1}{8}$  and  $\frac{1}{8}$ . (07 Marks)
  - For the first order Markoff model as shown below Fig.Q1(c), find the state probabilities, entropy of each state, entropy of the source and show that  $G_1 > H(s)$ . (10 Marks)

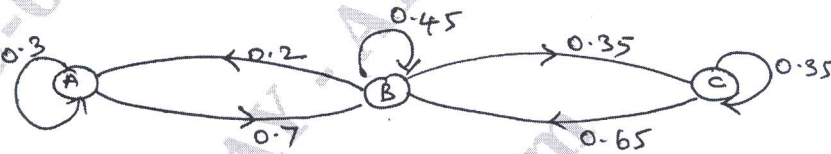


Fig.Q1(c)

- A source emits an independent sequence of symbols from an alphabet consisting of five symbols A, B, C, D, E with probabilities  $\frac{1}{4}$ ,  $\frac{1}{8}$ ,  $\frac{1}{8}$ ,  $\frac{3}{16}$  and  $\frac{5}{16}$  respectively. Find the binary code using Shannon's binary algorithm. Also find coding efficiency. (10 Marks)
  - For the channel matrix shown below for which  $P(x_1) = \frac{1}{2}$ ,  $P(x_2) = P(x_3) = \frac{1}{4}$  and  $r_s = 10,000/\text{sec}$ . Find  $H(x)$ ,  $H(y)$ ,  $H(y/x)$ ,  $H(x,y)$ ,  $I(x,y)$  and channel capacity. (10 Marks)

$$P(y/x) = \begin{bmatrix} 0.8 & 0.2 & 0 \\ 0.1 & 0.8 & 0.1 \\ 0 & 0.2 & 0.8 \end{bmatrix}$$

(10 Marks)

- For the following source,  
 $S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7\}$  with probabilities  
 $P = \left\{ \frac{1}{3}, \frac{1}{3}, \frac{1}{9}, \frac{1}{9}, \frac{1}{27}, \frac{1}{27}, \frac{1}{27} \right\}$ 
    - Find the compact Huffman code when  $X = \{0, 1\}$  and  $X = \{0, 1, 2\}$
    - Find the coding efficiency for the above codes. (10 Marks)
  - Two noisy channels are cascaded whose channel matrices are given by

$$P(y/x) = \begin{bmatrix} 1/4 & 1/2 & 1/4 \\ 1/2 & 1/4 & 1/4 \end{bmatrix}, P(z/y) = \begin{bmatrix} 1/3 & 2/3 & 0 \\ 2/3 & 0 & 1/3 \\ 0 & 1/3 & 2/3 \end{bmatrix}$$

With  $P(x_1) = P(x_2) = 0.5$ , show that  $I(x,y) > I(x, z)$ .

(10 Marks)

- 4 a. For the channel matrix shown below, find channel capacity and derive the expression for same.

$$P(b/a) = \begin{bmatrix} 0.4 & 0.3 & 0.2 & 0.1 \\ 0.4 & 0.1 & 0.3 & 0.2 \\ 0.1 & 0.2 & 0.4 & 0.3 \end{bmatrix} \quad (06 \text{ Marks})$$

- b. State and prove Shannon's Hartley law. Derive the expression for the upper limit of channel capacity. (06 Marks)
- c. An analog signal has 4KHz bandwidth. The signal is sampled at 2.5 times the Nyquist rate and each sample is quantized to 256 equally likely levels. All samples are statistically independent.
- What is information rate of the signal
  - Can the output of this source be transmitted without errors over a Gaussian channel with a band width of 50KHz and S/N ratio of 23dB?
  - What will be the bandwidth required for transmitting the o/p of the signal without errors, if S/N ratio is 10dB. (08 Marks)

### PART - B

- 5 a. Prove that  $C \cdot H^T = 0$ . (04 Marks)
- b. The parity check bits of a (8, 4) linear block code is given by,  
 $C_5 = d_1 + d_2 + d_4$ ,  $C_6 = d_1 + d_2 + d_3$ ,  
 $C_7 = d_1 + d_3 + d_4$ ,  $C_8 = d_2 + d_3 + d_4$ ,  
 where  $d_1$   $d_2$   $d_3$  and  $d_4$  are databits.
- Find generator and parity check matrix of this code
  - Find all the code vectors
  - Draw the encoding and syndrome calculation circuit. (08 Marks)
- c. Design a linear block code with a minimum distance of three and message block size of eight bits. (08 Marks)
- 6 a. Given the generator polynomial of (7, 4) cyclic code  $g(x) = 1 + x^2 + x^3$ ,
- Find the code vector of messages 0101, 0111, 1010 and 1100 in systematic form
  - Draw the syndrome calculation circuit. (12 Marks)
- b. Consider a (15, 11) cyclic code generated by  $g(x) = 1 + x^3 + x^4$ . Derive a feedback shift register encoder circuit. Illustrate the encoding procedure with the message 11101000111 by listing the state of registers. (08 Marks)
- 7 Write a short note on:
- Golay codes
  - Shortened cyclic code
  - Rs codes
  - Burst error correcting codes. (20 Marks)
- 8 Consider the (3, 1, 2) convolution code with impulse response  $g^{(1)} = 110$ ,  $g^{(2)} = 101$ ,  $g^{(3)} = 111$ .
- Draw the endoder block diagram
  - Find generator matrix
  - Find the codeword corresponds to the message sequence 11101 using :
    - Time domain approach
    - Transform domain approach. (20 Marks)

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